Model Evaluation Based on Cluster Analysis

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Overview

- Winter cluster analysis for SFBA – by UC Davis
- Extension to pattern-based model evaluation
- Application to winter $PM_{2.5}$ simulation
- Research proposal to improve model performance

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SFBA Winter Meteorological Clustering

- SFBA clustering results for Nov-Mar 1996-2007 (1754 days)
  - 5 clusters (weather patterns) with distinct $PM_{2.5}$ characteristics
  - Weather patterns allow categorical inference of air quality

Meteorology		SFBA Air Quality
R2	→	very poor
R3	→	poor
R1	→	moderate
V and Z	→	clean

Winter $PM_{2.5}$ simulations need to reproduce R2 weather pattern!!!

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Pattern-based Model Evaluation

Match MM5-simulated wind fields against cluster patterns.

Air quality model performance degraded for mismatched conditions.

Novel and powerful statistical method to:

1. Assess representativeness of simulated events
2. Evaluate ability of met. model to reproduce atmospheric features influencing air quality
3. Infer air quality model performance based on met. model performance
4. Minimize uncertainties for simulated pollutant sensitivities to emissions reductions

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Model evaluation results

R2 simulated as R1: CMAQ likely to underestimate PM!

MM5 simulation for Dec-Jan of 2000-01 & 2006-07 (128 days*)

Observed clusters		MM5 output classification				
name	# days	R1	R2	R3	Z	V
R1	31	28	0	0	4	0
R2	51	34	10	1	7	0
R3	23	14	0	4	4	3
Z	22	2	0	0	20	1
V	11	2	0	1	5	5

"true" patterns

simulated conditions

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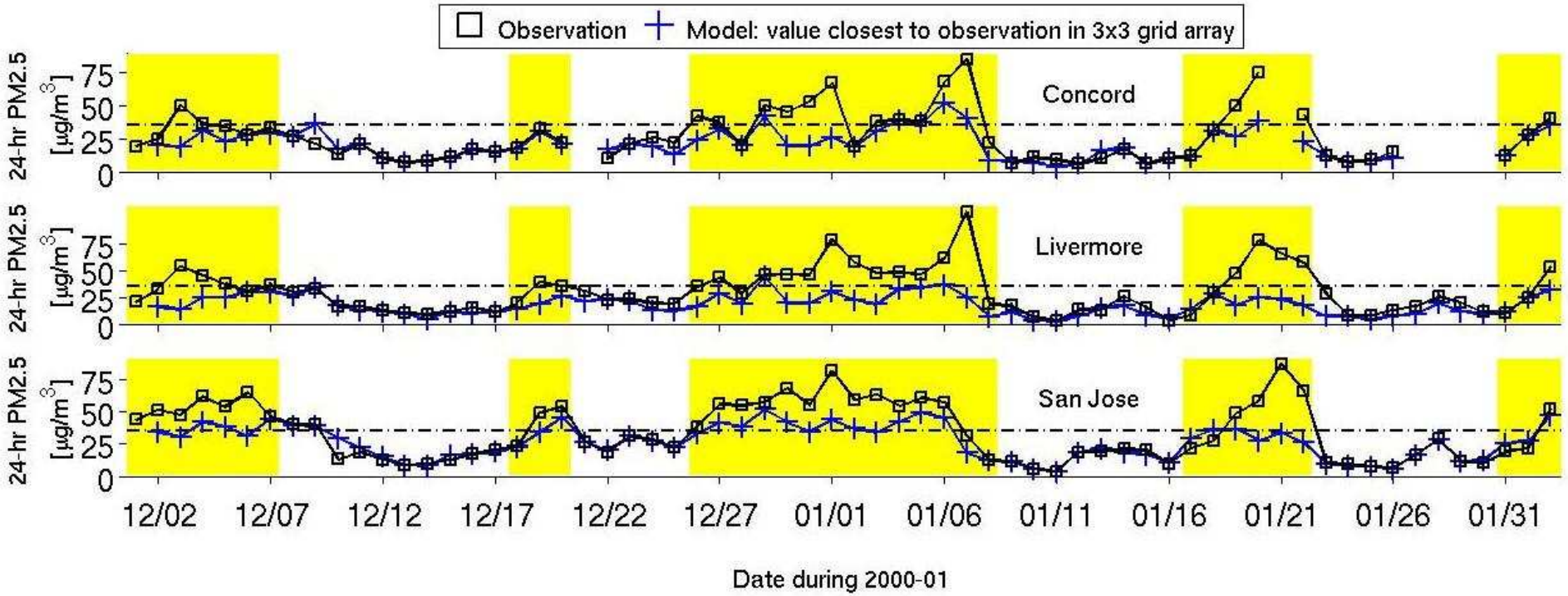
*rows/cols may not add because some days assigned to 2 clusters

CMAQ Seasonal $PM_{2.5}$ Performance

Yellow = R2 days (observed)



MM5 simulates most R2 days as having R1 conditions.
CMAQ simulates “very poor” air quality as “moderate.”

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Proposal for TC Consideration

- MM5 shortcoming requires further investigation
  - Rigorously evaluate of MM5 performance
  - Identify root cause of performance problem under high pressure conditions
  - Analyze ozone, PM, and toxics simulation periods
  - Characterize problem for Sacramento, SJV, and possibly elsewhere
  - WFR likely to exhibit same problem (under investigation)

- Contract third party investigator
  - Close feedback loop between meteorological and air quality modelers
  - Estimate $100k to fully diagnose problem and determine feasibility to correct it

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[supporting data to follow]

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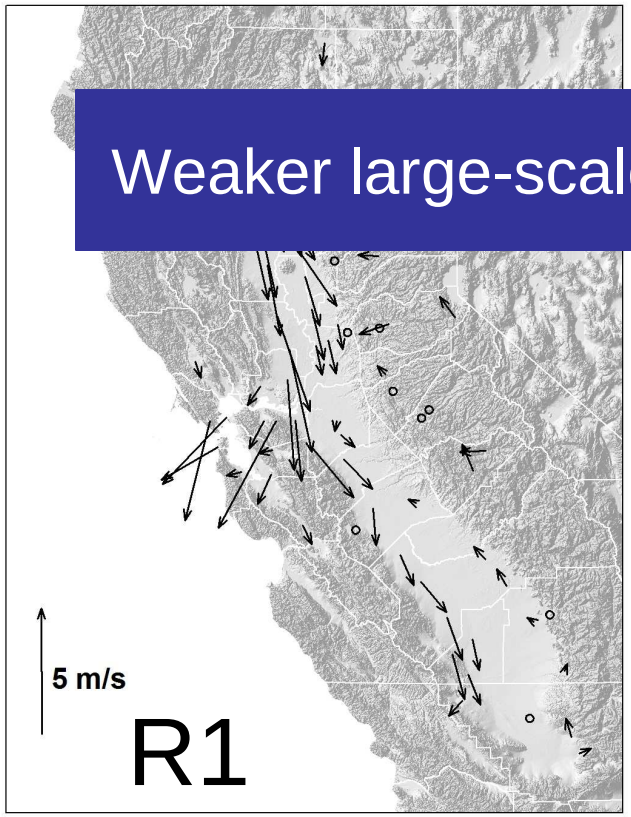
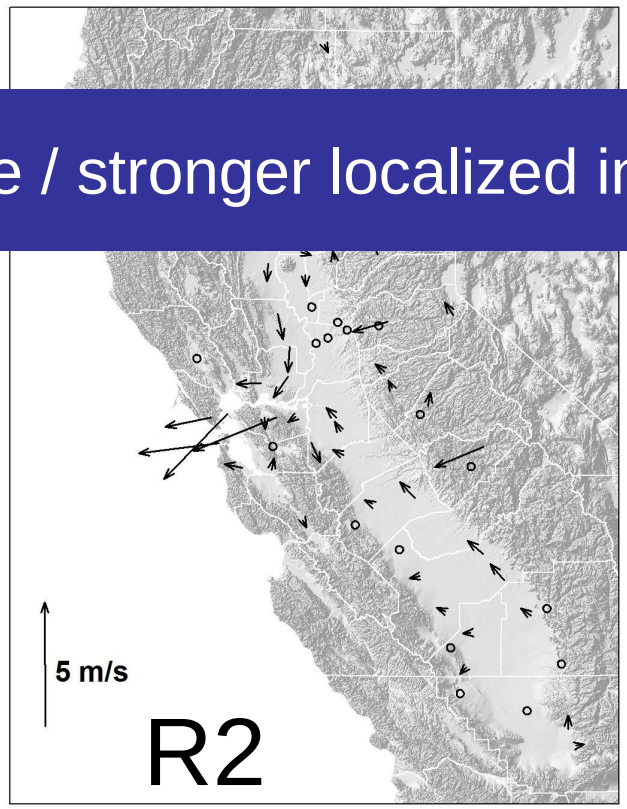
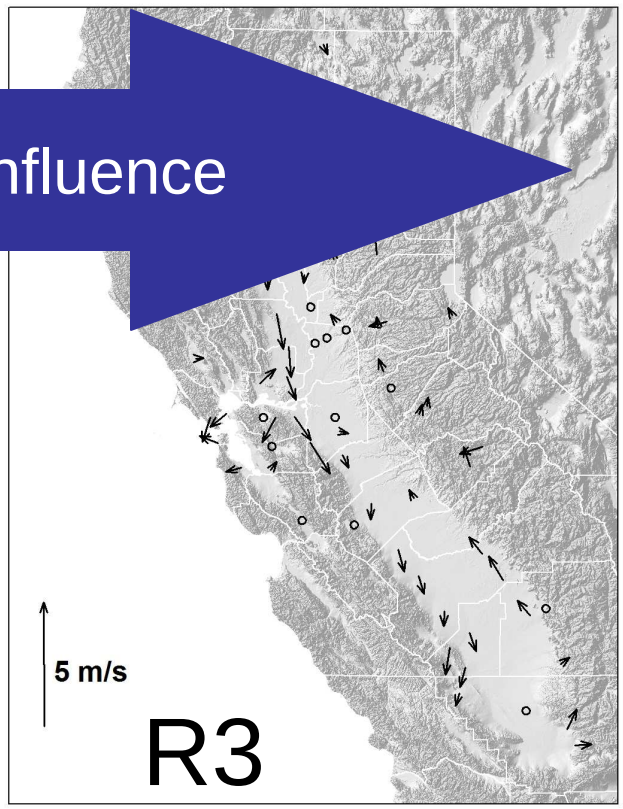
0900 PST Air Flows







Weaker large-scale / stronger localized influence

Strong pressure gradient
Strong northerly SV winds
Moderate PM levels
219 d, 7 exceedances

Weak pressure gradient
SFBA persistent easterly flow
Highest PM levels
422 d, 145 exceedances

Weakest pressure gradient
SFBA diurnally reversing winds
High PM levels
279 d, 25 exceedances

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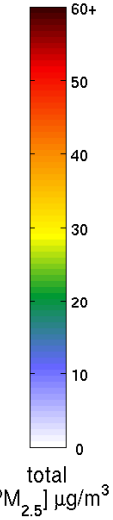
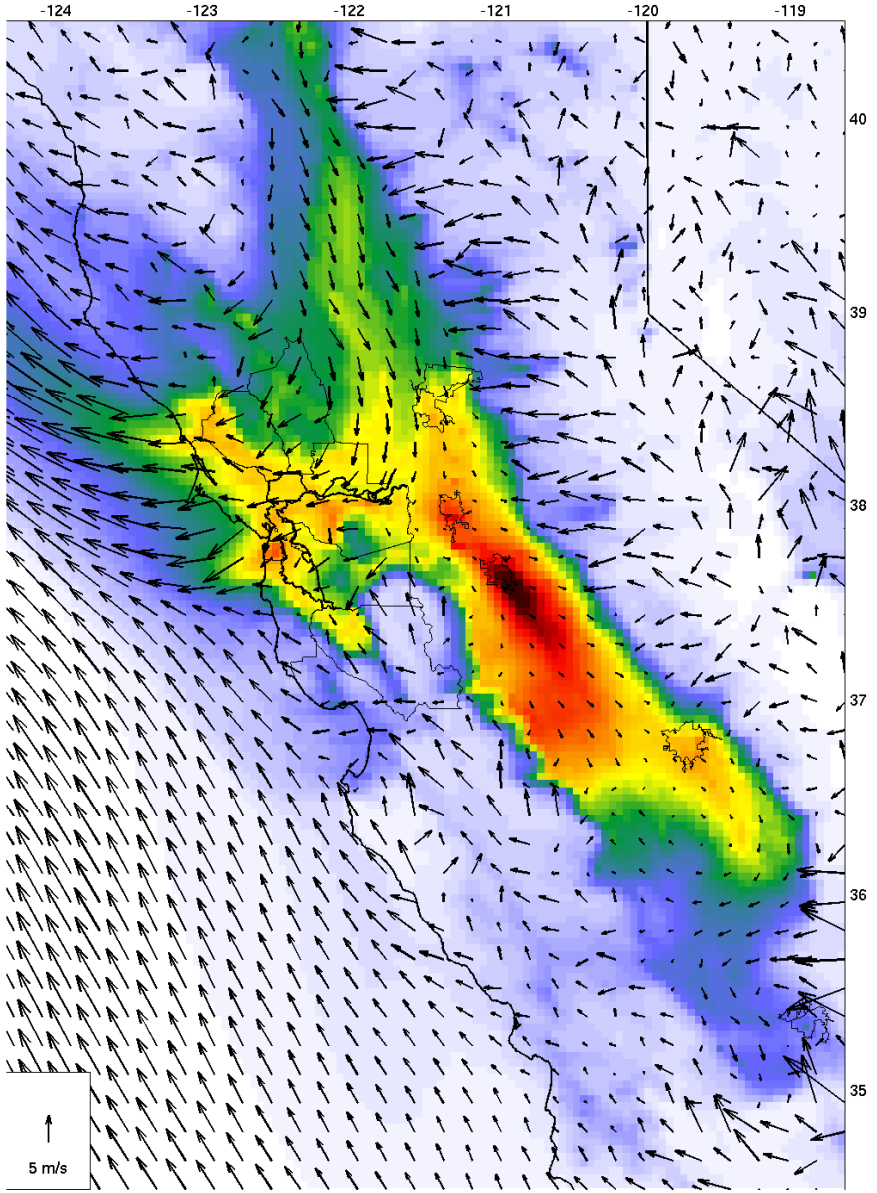
“R2-R1 Mismatch” on 1/21/2001

Observed
24-hr $PM_{2.5}$ levels

San Jose	1/21	86 µg/m^3
Livermore	1/21	66 µg/m^3
Sacramento	1/20	72 µg/m^3
Modesto	1/20	95 µg/m^3





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